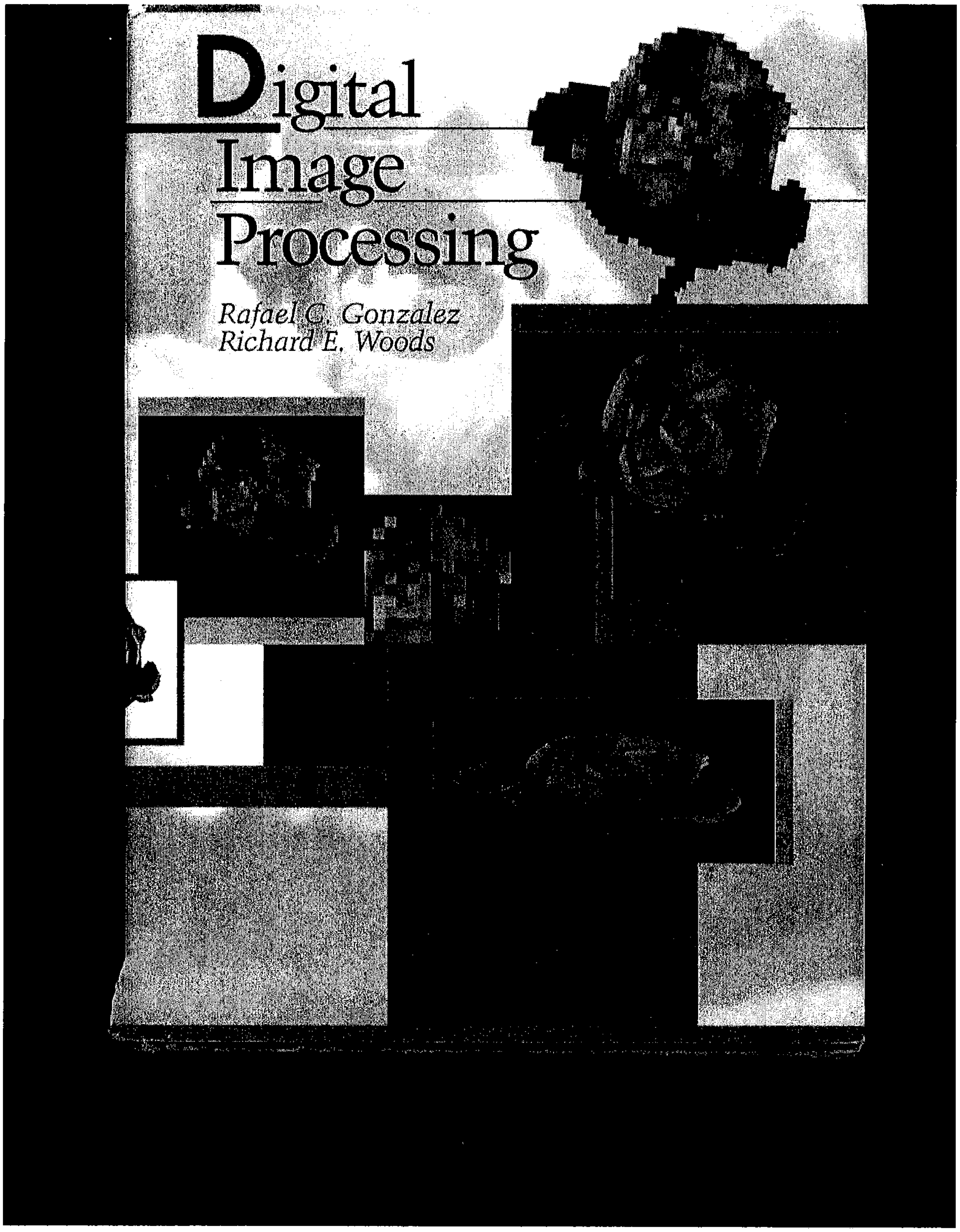

Digital Image Processing

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DIGITAL IMAGE PROCESSING

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CHAPTER 8

REPRESENTATION AND DESCRIPTION

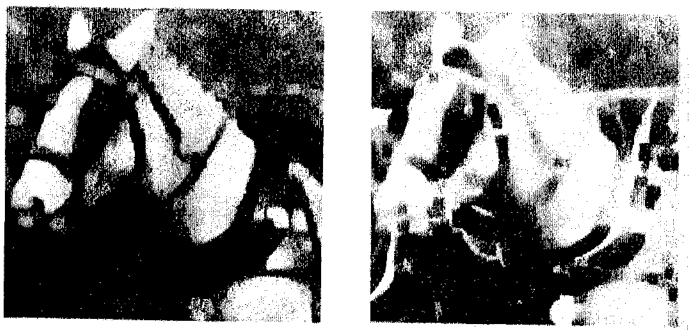
> Well, but reflect; have we not several times acknowledged that names rightly given are the likenesses and images of the things which they name?
>
> *Socrates*

After an image has been segmented into regions by methods such as those discussed in Chapter 7, the resulting aggregate of segmented pixels usually are represented and described in a form suitable for further computer processing. Basically, representing a region involves two choices: (1) we can represent the region in terms of its external characteristics (its boundary), or (2) we can represent it in terms of its internal characteristics (the pixels comprising the region). Choosing a representation scheme, however, is only part of the task of making the data useful to a computer. The next task is to *describe* the region based on the chosen representation. For example, a region may be represented by its boundary with the boundary described by features such as its length, the orientation of the straight line joining the extreme points, and the number of concavities in the boundary.

Generally, an external representation is chosen when the primary focus is on shape characteristics. An internal representation is selected when the primary focus is on reflectivity properties, such as color and texture. In either case, the features selected as descriptors should be as insensitive as possible to variations such as changes in size, translation, and rotation. For the most part, the descriptors discussed in this chapter satisfy one or more of these properties.

8.1 REPRESENTATION SCHEMES

The segmentation techniques discussed in Chapter 7 yield raw data in the form of pixels along a boundary or pixels contained in a region. Although these data are sometimes used directly to obtain descriptors (as in determining the texture



(a) (b)

Figure 8.47 (a) Opening and (b) closing of Fig. 8.45(a). (Courtesy of A. Morris, Leica Cambridge, Ltd.)

were processed by using the structuring element discussed in connection with Fig. 8.45.

Morphological smoothing. One way to achieve smoothing is to perform a morphological opening followed by a closing. The net result of these two operations is to remove or attenuate both bright and dark artifacts or noise. Figure 8.48 shows a smoothed version of the original image shown in Fig. 8.45(a).

Morphological gradient. In addition to the operations discussed earlier in connection with the removal of small dark and bright artifacts, dilation and erosion often are used to compute the *morphological gradient* of an image, denoted g:

$$g = (f \oplus b) - (f \ominus b). \tag{8.4-37}$$

Figure 8.49 shows the result of computing the morphological gradient of the image shown in Fig. 8.45(a). As expected, the morphological gradient highlights sharp gray-level transitions in the input image. As opposed to gradients obtained using methods such as a Sobel operation, morphological gradients obtained using symmetrical structuring elements tend to depend less on edge directionality. The price paid for this advantage is a significant increase in computational requirements.

Top-hat transformation. The so called morphological *top-hat* transformation of an image, denoted h, is defined as

$$h = f - (f \circ b) \tag{8.4-38}$$

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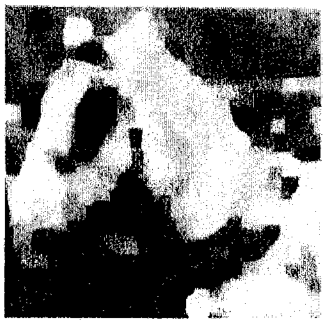


Figure 8.48 Morphological smoothing of the image in Fig. 8.45(a). (Courtesy of A. Morris, Leica Cambridge, Ltd.)

where, as before, f is the input image and b is the structuring element function. This transformation—which owes its original name to the use of a cylindrical or parallelepiped structuring element function with a flat top—is useful for enhancing detail in the presence of shading. Figure 8.50 shows the result of performing a top-hat transformation on the image of Fig. 8.45(a). Note the enhancement of detail in the background region below the lower part of the horse's head.

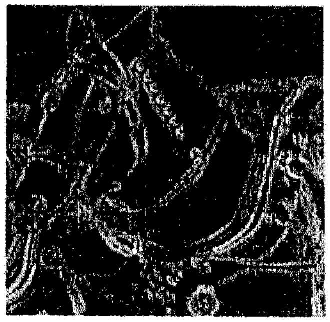
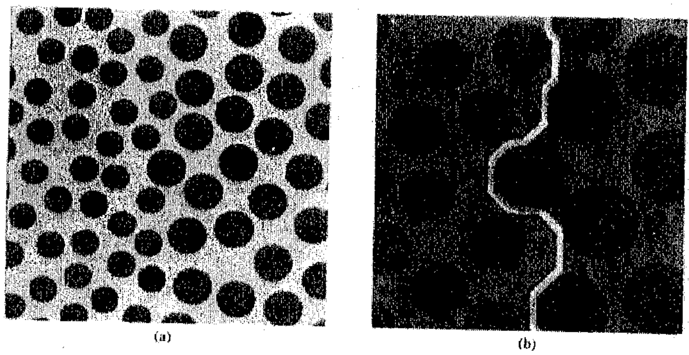


Figure 8.49 Morphological gradient of the image in Fig. 8.45(a). (Courtesy of A. Morris, Leica Cambridge, Ltd.)

Figure 8.50 Result of performing a top-hat transformation on the image of Fig. 8.45(a). (Courtesy of A. Morris, Leica Cambridge, Ltd.)

Textural segmentation. Figure 8.51(a) shows a simple gray-scale image composed of two texture regions. The region on the right consists of circular blobs of larger diameter than those on the left. The objective is to find the boundary between the two regions based on their textural content. Although various possible solutions based on the material in Chapter 7 may come immediately



(a) (b)

Figure 8.51 (a) Original image; (b) segmentation boundary. (Courtesy of A. Morris, Leica Cambridge, Ltd.)

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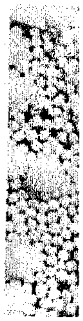

Figure 8.
(Courtesy